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First Named Inventor	Ahmad Ghaemmaghami
Art Unit	2815
Examiner Name	Jose R. Diaz
Attorney Docket Number	E0545

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: Ghaemmaghami et al.

Serial No.: 09/497,320

Filed: February 3, 2000

Group Art Unit: 2815

Before the Examiner: Jose R. Diaz

Title: METHOD AND SYSTEM FOR PROVIDING HALO IMPLANT TO A SEMICONDUCTOR DEVICE WITH MINIMAL IMPACT TO THE JUNCTION CAPACITANCE

REPLY BRIEF

Mail Stop Appeal Brief - Patents
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Dear Sir:

This Reply Brief is being submitted in response to the Examiner's Answer dated October 4, 2005, with a two-month statutory period for response set to expire on December 4, 2005.

CERTIFICATION UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450, on November 9, 2005.

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I. RESPONSE TO EXAMINER'S ARGUMENTS

A. Response to Examiner's argument that Examiner provided appropriate motivation for modifying Hori with Wolf as discussed on page 5 of Examiner's Answer.

The Examiner admits that Hori does not teach providing a photoresist layer, as recited in claim 1 and similarly in claim 8. Examiner's Answer, page 5. The Examiner cites Wolf as teaching a photoresist layer. Examiner's Answer, page 5. The Examiner's motivation for modifying Hori with Wolf to include a photoresist layer is "that the photoresist have good ion stopping power in the smallest thickness (see last paragraph of page 321 of Wolf et al.)." Examiner's Answer, page 5.

Most if not all inventions arise from a combination of old elements. *See In re Rouffet*, 47 U.S.P.Q.2d 1453, 1457 (Fed. Cir. 1998). Obviousness is determined from the vantage point of a hypothetical person having ordinary skill in the art to which the patent pertains. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1457 (Fed. Cir. 1998). Therefore, an Examiner may often find every element of a claimed invention may often be found in the prior art. *Id.* However, identification in the prior art of each individual part claimed is insufficient to defeat patentability of the whole claimed invention. *See Id.* In order to establish a *prima facie* case of obviousness, the Examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1458 (Fed. Cir. 1998). That is, the Examiner must provide some suggestion or motivation, either in the references themselves, the knowledge of one of ordinary skill in the art, or, in some case, the nature of the problem to be solved, to modify the reference or to combine reference teachings. *See In re Dembiczak*, 175 F.3d 994, 999, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999). Whether the Examiner relies on an express or an implicit showing, the Examiner must provide particular findings related thereto. *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000).

The Examiner's motivation (that the photoresist have good ion stopping power in the smallest thickness (see last paragraph of page 321 of Wolf et al.)) does not provide reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would modify Hori to include the above-cited claim limitation. Accordingly, the Examiner has not presented a *prima facie* case of obviousness in rejecting claims 1, 4-5, 8 and 11-12. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1458 (Fed. Cir. 1998).

The passage cited by the Examiner for support for his motivation (page 321 of Wolf) states that many materials are used for such masking purposes in IC fabrication including photoresist, SiO_2, Si_3N_4, polysilicon, metal films and polymide. Page 321. Wolf continues by saying that the desirable features of an implantation mask material include: a) the material should have good ion stopping power in the smallest thickness. Page 321. There is no language that specifies using a photoresist over the other mentioned materials, such as SiO_2 because a photoresist has good ion stopping power in the smallest thickness as alleged by the Examiner. The Examiner has noted to Appellants on pages 9-10 of the Examiner's Answer that the Examiner is relying upon the embodiment of Hori using silicon dioxide. Merely citing to a passage that lists both photoresist and SiO_2 as materials used for masking purposes and then citing to a statement that the material should have good ion stopping power in the smallest thickness is not a reason as to why one skilled in the art would modify Hori to include a photoresist layer.

Hori addresses the problem of developing a semiconductor transistor with a high packing density that is able to have a high withstand voltage and a high drivability in which the invention threshold voltage can be easily controlled. Column 1, lines 11-14; Abstract. The Examiner has not indicated how replacing SiO_2 as a mask with a photoresist relates to addressing the problem of developing a semiconductor transistor with a high packing density that is able to have a high withstand voltage and a high drivability in which the invention threshold voltage can be easily controlled. Thus, the Examiner has not provided reasons as to why one of ordinary skill in the art would

modify Hori to include the above-cited claim limitation. Since the Examiner has not provide such reasons, the Examiner's motivation is insufficient to support a *prima facie* case of obviousness for rejecting claims 1, 4-5, 8 and 11-12. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1458 (Fed. Cir. 1998).

B. Response to Examiner's statement that the Examiner is relying upon the embodiment of Hori using silicon dioxide instead of titanium silicide in connection with the rejection of claims 1, 4-5, 8 and 11-12, as discussed on pages 9-11 of Examiner's Answer.

The Examiner has pointed out that the Examiner is relying upon the embodiment of Hori using silicon dioxide instead of titanium silicide. Examiner's Answer, pages 9-10. Appellants thank the Examiner for noting which embodiment of Hori the Examiner is relying upon.

Appellants though respectfully assert that the arguments made on pages 4-9 of Appellants' Amended Supplemental Appeal Brief still apply by replacing "titanium silicide" with silicon dioxide. Hori teaches that in the simulation using a computer, an implant mask of a SiO_2 film is used instead of a $TiSi_2$ film. Column 7, lines 45-46. Since Hori teaches that the ion stopper power of titanium silicide is about 1.5 times higher than that of silicon and that consequently the boron ions are not allowed to permeate near pn-juncitons (column 6, lines 64-68), one would assume that silicon dioxide would have similar properties to titanium silicide since Hori teaches the substitution of titanium silicide with silicon dioxide. Hence, in the embodiment with silicon oxide, the ion stopper power of silicon oxide is higher than that of silicon and consequently the boron ions are not allowed to permeate near pn-juncitons (column 6, lines 64-68).

The Examiner admits that Hori does not teach using a photoresist layer. Examiner's Answer, page 5. The Examiner cites page 321 of Wolf as teaching using a photoresist in place of silicon dioxide as a mask. Examiner's Answer, page 5. However, by modifying Hori to replace the silicon dioxide with a photoresist, as suggested by the Examiner, the principle of operation in Hori would change and subsequently render the

operation of Hori to perform its purpose unsatisfactorily. By substituting the silicon dioxide with the photoresist, the ion stopping power will be less than that of silicon and hence not able to prevent boron ions from permeating near pn-junctions between the n+-type source and drain regions and the substrate.

The Examiner has not provided any evidence that would suggest that a photoresist, with the same thickness as silicon dioxide, would have an ion stopping power similar to silicon dioxide which is higher than that of silicon. A photoresist though has less ion stopping power than silicon dioxide and even lower than that of silicon. Appellants respectfully refer the Board to the periodic table of elements which indicates that silicon has an atomic number of 14, carbon has an atomic number of 6, and oxygen has an atomic number of 8. The greater the number of the atomic number, i.e., the greater number of protons in the nucleus and the number of electrons orbiting the nucleus, the greater the ion stopping power. Since the atomic number of carbon, which a photoresist is mainly comprised of, is lower than the atomic number of silicon, one may conclude that the ion stopping power of a photoresist is less than that of silicon. Hence, by replacing silicon oxide with a photoresist of the same thickness, the ion stopping power will be less than that of silicon and hence may not be able to prevent boron ions from permeating near pn–junctions between the n^+-type source and drain regions and the substrate. Hence, by combining Hori with Wolf, Hori would no longer be able to form p^+-type semiconductor regions only in a channel region thereby not being able to obtain a high speed semiconductor transistor device with a small parasitic junction capacitance and a low impurity concentration in the center of the channel region. Thus, by combining Hori with Wolf, the principle of operation in Hori would change, and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

Furthermore, Appellants direct the Board's attention to Figures 36(a) and (b) of

Wolf which indicate the thicknesses of silicon dioxide and photoresist, respectively, to stop 99.99% of incident ions. Hori specifies that the titanium silicide films 8a and 8b have a thickness of 60 to 100nm. Column 6, lines 43-44. Hori further teaches that the boron ions are then implanted at a dose of 2 to $10X10^{12}$ cm^{-2} at 30 to 50 keV using titanium silicide films 8a and 8b as a mask. Column 6, lines 53-54. Hori further teaches using a SiO_2 film instead of a $TiSi_2$ film in a computer simulation. Column 7, lines 45-46. Hence, one can assume that the thicknesses of the titanium silicide films 8a and 8b would roughly correspond to the thicknesses of the SiO_2 films used in the embodiment using a SiO_2 film instead of a $TiSi_2$ film.

The Examiner cites Figures 36(a) and 36(b) of Wolf as evidence that the photoresist has an ability to stop 99.99% of ionic species for the thickness recited in the claims. Examiner's Answer, page 10. However, one must first look at the thickness recited in Hori, which reference is being modified. The titanium silicide films 8a and 8b have a thickness of 60 to 100nm. Column 6, lines 43-44. The boron ions are then implanted at a dose of 2 to $10X10^{12}$ cm^{-2} at 30 to 50 keV using titanium silicide films 8a and 8b as a mask. Column 6, lines 53-54. Referring to Figure 36(b) of Wolf, in order to stop 99.99% of boron ions being implanted between 30 to 50 keV, the photoresist must have a thickness between .22 and .32 μm (220 to 320 nm). The 220 to 320 nm is far in excess of the thickness of the titanium silicide films recited in Hori. Appellants note that the Examiner is citing the embodiment of SiO_2 of Hori. However, Hori only makes reference to the SiO_2 embodiment by stating that it is used instead of a $TiSi_2$ film in a computer simulation. Column 7, lines 45-46. Hence, Appellants believe that the thickness of the silicon dioxide films replacing the titanium silicide films 8a and 8b should roughly be equivalent.

By modifying Hori to have a photoresist layer with a thickness between 220 to 320 nm instead of 60 to 100nm, the angle at which the boron ions would have to be implanted into the substrate would have to be steeper than 25 to 45 degrees. For example, the angle would be less than 20 degrees (e.g., 10 degrees) or greater than 60 degrees (e.g., 80 degrees). Hori teaches that the boron ions are implanted into a substrate

at such a large angle (an angle of ion beams to a normal line of a main surface of the substrate) as 20 to 60 degrees, preferably 25 to 45 degrees. Column 6, lines 56-61. By replacing titanium silicide (or alternatively silicon oxide) with photoresist and consequently increasing the thickness of the mask, the angle at which the boron ions would have to be implanted into the substrate would have to be steeper than 25 to 45 degrees. For example, the angle would be less than 20 degrees (e.g., 10 degrees) or greater than 60 degrees (e.g., 80 degrees). This would change the principle of operation in Hori and subsequently render the operation of Hori to perform its purpose unsatisfactorily. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 1, 4-5, 7-8, 11-12 and 14. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

Furthermore, the Examiner asserts that Figures 36(a) and 36(b) of Wolf evidences that the photoresist has an ability to stop 99.99% of ionic species for the thickness recited in the claims. Examiner's Answer, page 10. Claim 18 recites a photoresist layer between .1 μm and .2 μm. This corresponds to 100 nm to 200 nm. According to Figure 36(b) of Wolf, in order to stop 99.99% of boron ions being implanted between 30 to 50 keV, the photoresist must have a thickness between .22 and .32 μm (220 to 320 nm) which is outside the range claimed. The Examiner asserts that Wolf teaches a photoresist thickness of .2 μm at 30 keV. Examiner's Answer, page 11. However, upon reviewing Figure 36(b), Wolf clearly indicates that the photoresist thickness is in excess of 2 μm at 30 keV.

The Examiner states that Appellants argued on page 7 of Appellants' Amended Supplemental Appeal Brief that the Examiner failed to provide a comparison between the silicon oxide and the photoresist. Examiner's Answer, page 10. Appellants agree that the Examiner provides a comparison between silicon oxide and the photoresist by citing Figures 36(a) and (b) of Wolf. To clarify, Appellants were only asserting that the Examiner must provide a motivation for modifying Hori from using silicon dioxide films

to using photoresist and that hence a comparison between silicon dioxide and photoresist is necessary.

C. Response to Examiner's statement that the Examiner is relying upon the embodiment of Hori using silicon dioxide instead of titanium silicide in connection with the rejection of claims 7 and 14, as discussed on pages 11-12 of Examiner's Answer.

The Examiner has pointed out that the Examiner is relying upon the embodiment of Hori using silicon dioxide instead of titanium silicide. Examiner's Answer, pages 11-12. Appellants thank the Examiner for noting which embodiment of Hori the Examiner is relying upon. Further, Appellants note to the Board that the arguments presented on pages 9-14 of Appellants' Amended Supplemental Appeal Brief are essentially duplicate of the arguments presented on pages 4-9 of Appellants' Amended Supplemental Appeal Brief and hence may be ignored. Claim 7 depends from claim 1 and hence is patentable over Hori in view of Wolf and in further view of Thackeray for at least the reasons that claim 1 is patentable over Hori in view of Wolf. Further, claim 14 depends from claim 8 and hence is patentable over Hori in view of Wolf and in further view of Thackeray for at least the reasons that claim 8 is patentable over Hori in view of Wolf.

D. Response to Examiner's argument that the combination of Liang with Wolf would not change the principle of operation of Liang, as discussed on pages 12-13 of Examiner's Answer.

The Examiner argues that the combination of Liang with Wolf does not change the principle of operation of Liang because Wolf requires a photoresist of about .2 μm which is within the claimed range. Examiner's Answer, page 12. However, whether or not Wolf requires a photoresist with a thickness within the claimed range is irrelevant as to whether the modification of Liang with such a thickness would change its principle of operation as discussed on pages 14-15 of Appellants' Amended Supplemental Appeal Brief.

The Examiner admits that Liang does not teach a second photoresist layer with a thickness between .1 μm and .2 μm. Examiner's Answer, page 7. The Examiner cites Wolf as teaching using a photoresist layer with a size of approximately .2 μm. Examiner's Answer, page 7. However, by modifying Liang to include a photoresist layer with a thickness between .1 μm and .2 μm, the principle of operation in Liang would change and subsequently render the operation of Liang to perform its purpose unsatisfactorily as discussed on pages 14-15 of Appellants' Amended Supplemental Appeal Brief. Therefore, the Examiner has not presented a *prima facie* case of obviousness for rejecting claims 18-20. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

Furthermore, Appellants respectfully disagree with the Examiner that the thickness of the photoresist to stop 99.99% of boron ions at an energy from about 15 keV to about 50 keV (implant energy cited by Liang) requires a thickness of about .2 μm or less. Examiner's Answer, page 12. Instead, as indicated in Figure 36(b) of Wolf, in order to stop 99.99% of boron ions at an energy of about 50 keV, the thickness of the photoresist should be at least .3 μm.

Furthermore, the Examiner's citation to *In re Wertheim* and *In re Woodruff* (Examiner's Answer, page 12), does not support the assertion that the combination of Liang and Wolf does not change the principle of operation of Liang. Instead, these citations are used when the claimed ranges overlap or lie inside the ranges disclosed by the prior art. This is irrelevant as to whether the modification of Liang to include a photoresist layer with a thickness between .1 μm and .2 μm would change its principle of operation as discussed on pages 14-15 of Appellants' Amended Supplemental Appeal Brief.

E. Response to Examiner's argument that Liang and Wolf, taken in combination, teach or suggest "an oxide trench; a drain region adjacent to said oxide trench; a source region adjacent to said oxide trench" as recited in claim 18, as discussed on page 13 of Examiner's Answer.

The Examiner now indicates that elements 14A and 14B of Liang form a single oxide trench. Examiner's Answer, page 13. However, Liang teaches that elements 14A and 14B are separate shallow trench isolation (STI) regions. Column 2, lines 60-63. Further, as illustrated in Figure 1C, elements 14A and 14B of Liang are identified separately by "14A" and "14B". If the teachings of Liang were to interpret STI regions 14A and 14B as being a single oxide trench, one would assume that these regions would have a common label, e.g., 14.

Furthermore, the Examiner cites U.S. 6,352,903 and "CMOS Digital Integrated Circuits: Analysis and Design" as support that elements 14A and 14B of Liang are a single oxide trench. Examiner's Answer, page 13. Appellants respectfully traverse. There is no evidence presented in either of these references that elements 14A and 14B and presumably element 14C of Liang are all considered a single trench. Instead, each element (14A, 14B and 14C) is a shallow trench isolation (STI) region as specified in Liang at column 2, lines 6-63. Therefore, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 18, since the Examiner is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

F. Response to Examiner's argument that Liang and Wolf, taken in combination, teach or suggest "a photoresist layer of a thickness between .1 μm and .2 μm over said oxide trench and a substantial portion of said source and drain region, wherein a halo implant is implanted using said photoresist layer and said gate as a mask" as recited in claim 18, as discussed on pages 13-14 of Examiner's Answer.

The Examiner cites *Playtex Products* as support that the term "substantial" is a meaningful modifier implying "approximate" rather than "perfect." Examiner's Answer, pages 13-14. However, in *Playtex Products*, the court was looking at the term "substantially" in connection with "flattened surfaces." *Playtex Products Inc. v. Procter & Gamble Co.*, 73 U.S.P.Q.2d 2010, 2014 (Fed. Cir. 2005). The court held that the term "substantially flattened surface" has unambiguous meaning that is resolved solely on the intrinsic record. *Id.* at 2014-2015. The court held that "substantially flattened surfaces"

does not require a "perfectly" flat surface and that the term "substantial" is a meaningful modifier implying "approximate" rather than "perfect." *Id.* at 2015.

Playtex Products does not support the assertion that the phrase "a substantial portion of the source and drain region" can essentially be ignored or interpreted to mean an insignificant portion which is the complete opposite of the wording of the claim. The Examiner has not cited to any intrinsic evidence (specification, claims, prosecution history) limiting the phrase "substantial portion of the source and drain region" to mean an insubstantial portion which the Examiner seems to elude. Instead, the phrase "substantial portion of the source and drain region" has an unambiguous meaning.

Appellants respectfully assert that Liang and Wolf, taken singly or in combination, do not teach or suggest "a photoresist layer of a thickness between .1 μm and .2 μm over said oxide trench and a substantial portion of said source and drain region, wherein a halo implant is implanted using said photoresist layer and said gate as a mask" as recited in claim 18. The Examiner cites element PR2 of Liang as teaching a photoresist layer; element 24D of Liang as teaching a drain region; element 24S of Liang as teaching a source region; and elements 14A and 14B as teaching the oxide trench. Examiner's Answer, page 7. Appellants respectfully traverse.

Liang instead teaches that mask PR2 overlies all of STI structure 14A but only half of STI structure 14B. If the Examiner is citing STI structure 14B as teaching the oxide trench as recited in claim 18, then the mark PR2 does not cover the oxide trench as required by claim 18. Furthermore, as illustrated in Figure 1C, the mask PR2 does not cover a substantial portion of element 24S (Examiner asserts that element 24S teaches a source region). Instead, the mask PR2 covers an insubstantial portion of element 24S. Hence, Liang does not teach a photoresist layer covering a substantial portion of a source region. Neither does the mask PR2 cover a substantial portion of element 24D (Examiner asserts that element 24D teaches a drain region). Therefore, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 18, since the Examiner

is relying upon an incorrect, factual predicate in support of the rejection. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1455 (Fed. Cir. 1998).

G. Response to Examiner's argument that the Examiner presented appropriate motivation for modifying Liang and Wolf with Thackeray, as discussed on page 15 of Examiner's Answer.

The Examiner states that as long as some motivation or suggestion to combine the references is provided by the prior art taken as a whole, the law does not require that the references be combined for the reasons contemplated by the inventor. Examiner's Answer, page 15. Appellants acknowledge that fact. However, Appellants maintain that the Examiner's motivation (to effectively activate the photoactive component of the photoresist system...to produce a pattern image) does not provide reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would modify Liang to include a photoresist layer that comprises a deep ultraviolet layer. Accordingly, the Examiner has not presented a *prima facie* case of obviousness in rejecting claim 20. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1458 (Fed. Cir. 1998).

Liang addresses the problem of junction leakage and junction short circuits to the substrate as the dimensions of the devices forming those circuits become smaller and smaller. Column 1, lines 41-46. The Examiner has not indicated how including a photoresist layer that comprises a deep ultraviolet layer addresses the problem of overcoming the problem of junction leakage and junction short circuits to the substrate as the dimensions of the devices forming those circuits become smaller and smaller. Effectively activating the photoactive component of the photoresist system to produce a pattern image is irrelevant to overcoming the problem of junction leakage and junction short circuits to the substrate as the dimensions of the devices forming those circuits become smaller and smaller. Thus, the Examiner has not provided reasons as to why one of ordinary skill in the art would modify Liang to include a photoresist layer that comprises a deep ultraviolet layer. Since the Examiner has not provide such reasons, the

Examiner's motivation is insufficient to support a *prima facie* case of obviousness for rejecting claim 20. *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1458 (Fed. Cir. 1998).

H. Other matters raised by the Examiner.

All other matters raised by the Examiner have been adequately addressed above and in Appellants' Amended Supplemental Appeal Brief and therefore will not be addressed herein for the sake of brevity.

II. CONCLUSION

For the reasons stated in Appellants' Amended Supplemental Appeal Brief, Appellants respectfully assert that the rejections of claims 1, 4, 5, 7, 8, 11, 12, 14 and 18-20 are in error. Appellants respectfully request reversal of the rejections and allowance of claims 1, 4, 5, 7, 8, 11, 12 and 14-20.

Respectfully submitted,

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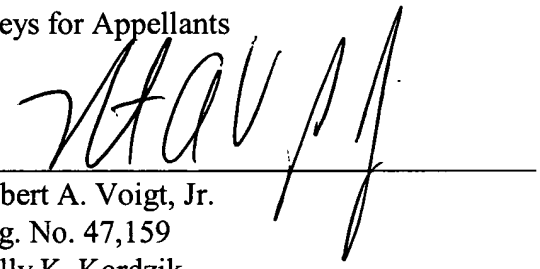
Attorneys for Appellants

By: 

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